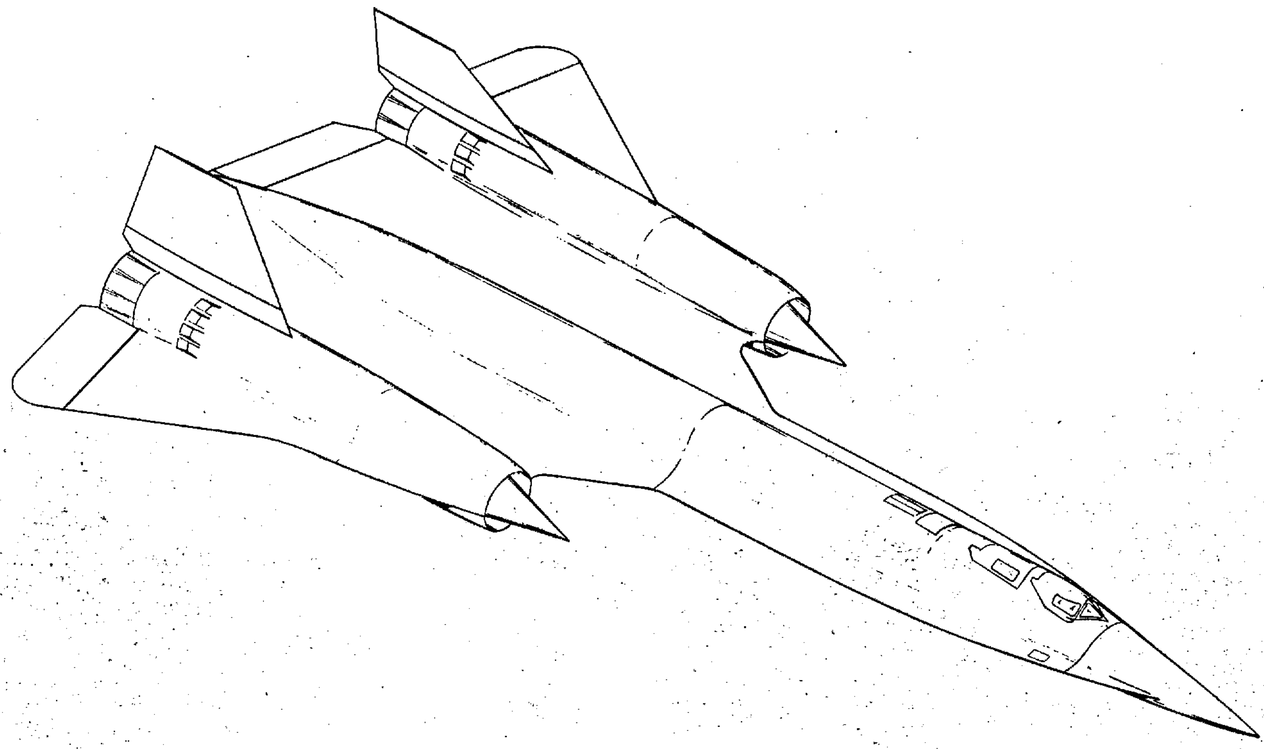

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12 May 1960

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PROPOSAL FOR AF-12 INTERCEPTOR

25X1A

Prepared by:

C L Johnson
C. L. Johnson

Approved for Release to:

Air Force — yes
D. B. — yes

By Clarence L Johnson
Clarence L. Johnson

AF-12 INTERCEPTOR

SUMMARY

The A-12 aircraft can be modified to do the long range interceptor mission of GOR 114 (AD-1A-4-61) revised 30 October 1958, with the following results:

1. The range, endurance, combat altitude and speed can be met or exceeded.

2. The ASG-18 with a 40-inch radar dish and 5 KVA power can be installed with either a two-place or single-place crew version.

3. Three GAR-9 missiles can be carried.

4. No capsule escape provisions are provided, but upward ejection seats are considered for this purpose. Emphasis is placed on low altitude, low velocity seat operation, but high velocity escape provisions match the Century series fighters.

5. Oxygen pre-breathing is not considered necessary, due to the provisions of complete dual pressurization systems and the latest pressure suits for the crew.

SUMMARY (cont.)

6. A 15 minute turn-around time can be obtained. This time is set by refueling and re-arming rate. A four to five minute scramble time seems feasible.

7. The program cost for 200 airplanes, including J-58 engines, ASG-18 radars (but no GAR-9's), plus spares and G.H.E., is

[redacted]

8. The delivery span covers the period from September 1962 (for the first production aircraft to test) to mid-1966 for the last delivery.

9. The aircraft presented in this report carries less fuel but more armament and a larger radar dish than the single-place version presented in Report SP-157. The previously presented aircraft had considerably more range than the AF-12, but poorer over-all effectiveness.

10. The only external change required to convert the basic A-12 aircraft to the AF-12 is in the nose section, for the large radar dish and the cockpit canopy area.

COST ASSUMPTIONS

The estimated cost for the 200 aircraft program was based on the following assumptions:

25X1A
25X1A

1. The J-58 powerplants cost [redacted]

2. ASG-18 units, including spares and G.H.E., cost [redacted]

3. No GAR-9 missile costs are included.

4. Spares and G.H.E. for engines, autopilots, inertial guidance system and aircraft are included.

5. Three airplane years of flight testing by the manufacturer are included.

INTRODUCTION

This report describes an interceptor version of the A-12 reconnaissance airplane. The outstanding speed-altitude-range capability of the basic A-12 fulfills the performance requirements for an effective interceptor airplane, with a minimum of change or development required on the basic airplane.

The A-12 is a single-place, twin-engine supersonic airplane utilizing a thin, low aspect ratio wing. It is characterized by twin vertical tails, located atop mid-span mounted engine nacelles, and chines along the sides of the fuselage. These chines are constructed of materials which are non-reflective to radar signals, in order to avoid detection on reconnaissance missions. The chines have proven to be aerodynamically beneficial and contribute to the stability values and lift/drag ratios achieved in wind tunnel testing.

Since the anti-radar characteristics of the A-12 are of little value in an interceptor, it is proposed to replace the anti-radar materials now used for the chine construction with conventional materials, while retaining the same external shape. This will result in a reduction of airframe weight which can be used for offensive armament.

The ASG-18/GAR-9 control/missile system, as developed for the cancelled F-108 program, represents the most advanced armament

INTRODUCTION (cont.)

system available for interceptor aircraft in the immediate future. This study, therefore, is primarily devoted to adapting the A-12 aircraft to carrying the complete radar-armament system as designed and packaged for the two-place F-108 aircraft. A modification of this basic system to permit one-man operation is also presented for consideration.

AIRPLANE DESCRIPTION

Figure 1 shows the AF-12, modified from the A-12, to carry three GAR-9 air-to-air missiles and the ASG-18 radar and computer equipment necessary for accurate fire control. The missiles are contained within the chines along the fuselage, one on the right-hand side and two along the left-hand side. Lanyard firing will be used, with a thruster to displace the missile from its bay in the chine. Figure 2 compares the external shapes of the A-12 and the AF-12.

The 40-inch diameter scanning antenna is accommodated in the revised forward fuselage section of the airplane. The increased depth of the forward fuselage provides additional space below the cockpit floor for those radar components which must be located close to the antenna. Electronics and computer components are carried in the equipment bay behind the rear cockpit, as shown in Figure 3.

The only changes required in the forward cockpit are replacement of the driftsight/viewfinder with the attack display scope and installation of the platform selector panel in place of the larger navigation panel now used in the A-12.

The rear cockpit contains an ejection seat and overhead canopy similar to those in the flight station. The fire control officer is provided with the navigational, plotting, and armament controls, as described in the fire control section of this report.

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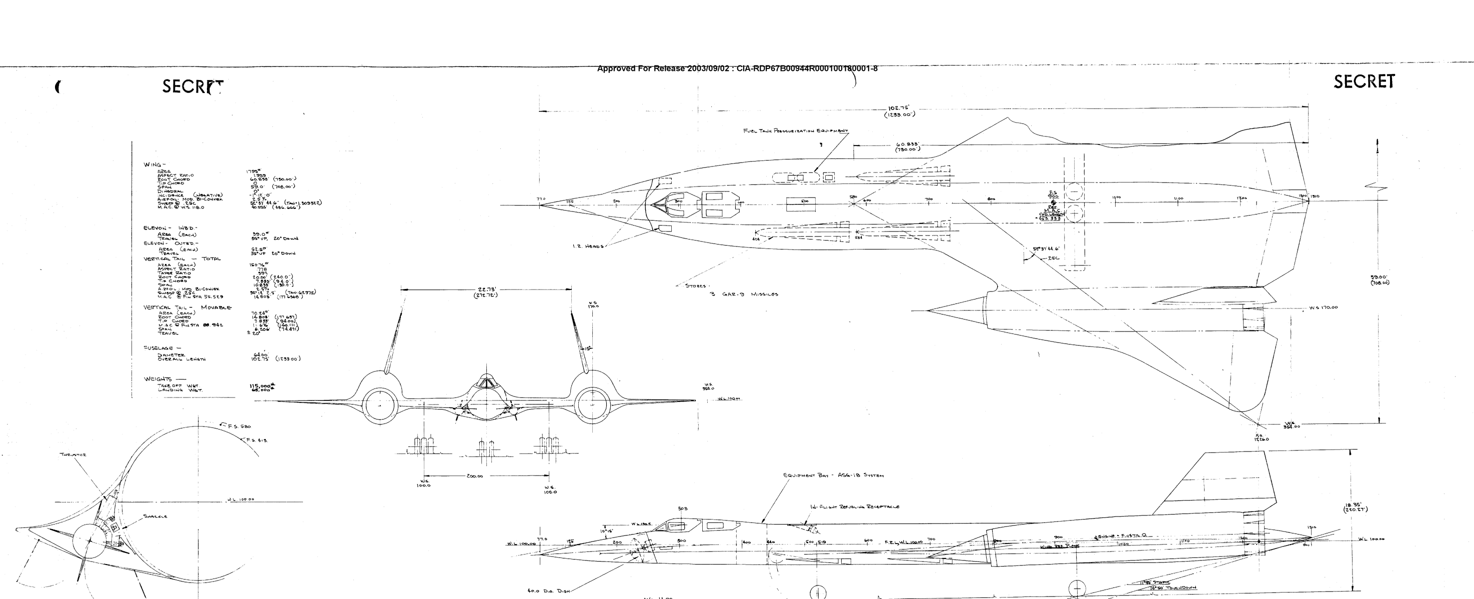
FIG. 1

WING –	
AREA	1795□'
ASPECT RATIO	1.939
ROOT CHORD	60.833' (730.00")
TIP CHORD	0
SPAN	59.0' (708.00")
DIHEDRAL	0°
INCIDENCE (NEGATIVE)	-1°-12'-0"
AIRFOIL - MOD. BI-CONVEX	2.5%
SWEEP @ .25C	52°37'44.6" (TAN=1.309322)
M.A.C. @ W.S. 118.0	40.555' (486.666")
ELEVON – INB'D. –	
AREA (EACH)	39.0□'
TRAVEL	35° UP, 20° DOWN
ELEVON – OUTB'D. –	
AREA (EACH)	52.5□'
TRAVEL	35° UP 20° DOWN
VERTICAL TAIL — TOTAL	
AREA (EACH)	150.76□'
ASPECT RATIO	.778
TAPER RATIO	.392
ROOT CHORD	20.00' (240.0")
TIP CHORD	7.833' (94.0")
SPAN	10.833' (130.0")
AIRFOIL - MOD BI-CONVEX	2.5%
SWEEP @ .25C	32°12'2.5" (TAN=.62975)
M.A.C. @ FIN STA 55.529	14.803' (177.6368")
VERTICAL TAIL – MOVABLE	
AREA (EACH)	70.24□'
ROOT CHORD	14.808' (177.697)
TIP CHORD	7.833' (94.00)
M.A.C. @ FIN STA 88.942	11.676' (140.111)
SPAN	6.206' (74.471)
TRAVEL	± 20°
FUSELAGE –	
DIAMETER	64.00"
OVERALL LENGTH	102.75' (1233.00")
WEIGHTS —	
TAKE OFF WGT.	115,000#
LANDING WGT.	65,000#



GENERAL ARRANGEMENT AF-12

DWN -4-60

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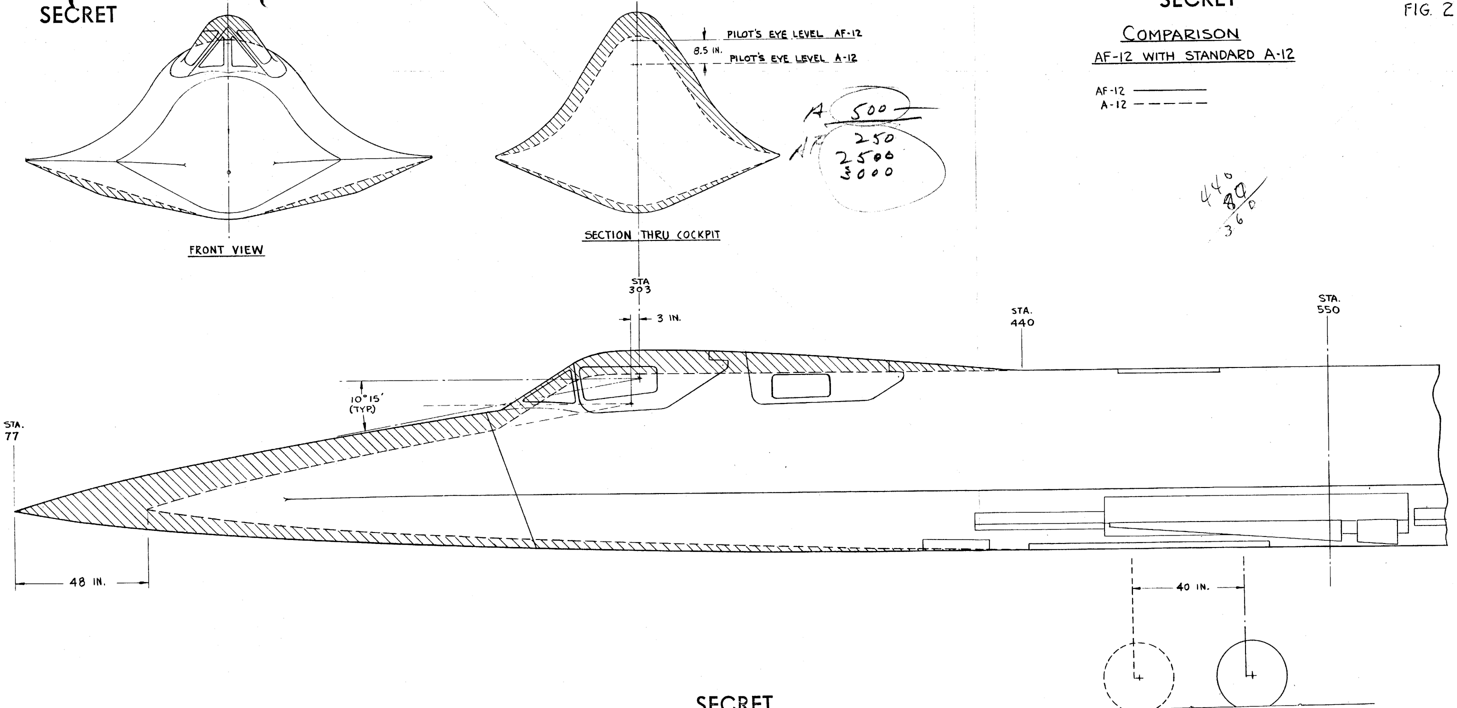
FIG. 2

COMPARISON

AF-12 WITH STANDARD A-12



A 500
AF 250
2500
3000

440
80
360

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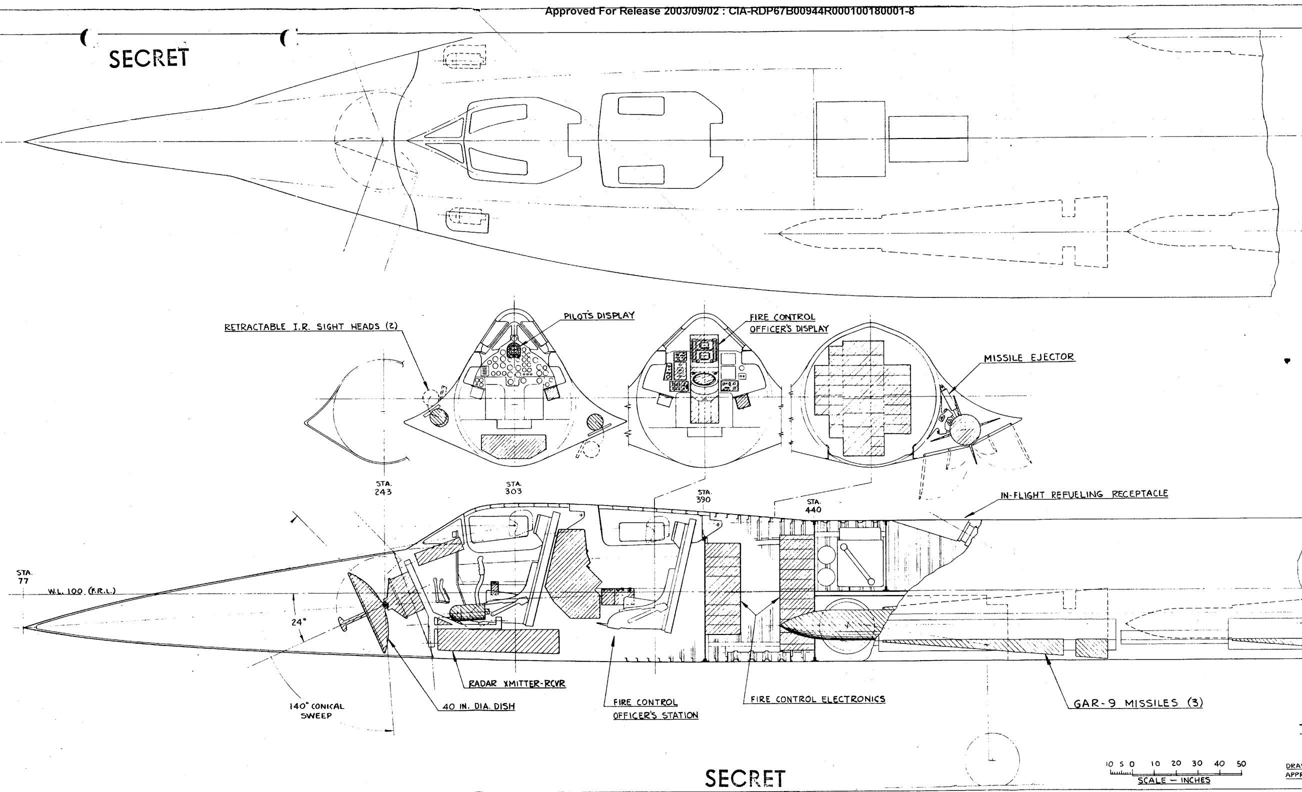
FIG. 3



INBOARD PROFILE
TWO-PLACE AF-12
INTERCEPTOR

DRAWN:
APPROVED: C. L. Johnson 5-10-60

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AIRPLANE DESCRIPTION (cont.)

Two I. R. sight heads, which are used as a secondary search and track means, are housed in the chines alongside the pilot's station. They are extended into the airstream only when in use, one above and one below the chine contour, and cover the same 140 degree sweep cone as the radar antenna.

The equipment bay aft of the rear cockpit contains ample space for rack-mounting the ASG-18 electronic and computer components in a pressurized and air conditioned environment. Racks are mounted on both forward and aft bulkheads, with adequate room provided for withdrawal of individual components and lowering them through a bottom access hatch.

Directly aft of the equipment bay, the configuration is identical to the basic A-12, consisting of the air conditioning equipment compartment in the top half of the fuselage and the nose wheel well in the lower half. These items, however, are located 40 inches farther aft than in the A-12, since the fuel tank area of the fuselage was shortened 40 inches in order to reduce fuel weight by the amount of structure and armament weight added. This length reduction maintains proper balance and airplane stability characteristics.

The dual-wheeled nose gear will require some redesign in order to strengthen it for the higher loads resulting from the shorter wheel base, and also because the landing weight of the interceptor is higher than that

AIRPLANE DESCRIPTION (cont.)

of the A-12. The three-wheeled main gear assemblies will also require beef-up for the higher landing weight.

Directly aft of the air conditioning bay, and above the nose wheel well, the fuselage becomes an integral fuel tank.

Fuel System

9,200 gallons of low vapor pressure hydrocarbon fuel are carried in six nearly equal size integral fuselage and wing tanks, as shown in Fig. 4.

A single point fueling receptacle is located in the most forward position of the front tank. This may be used for both ground and aerial fueling. A large trunk line connects to the receptacle and passes through each tank. Distribution tubes branch off from the trunk line into each tank. Metering is accomplished by calibrated orifices located downstream of the dual shutoff valves.

A preflight check panel located near the fueling receptacle has two functions -- to prove the operation of the refueling shutoff valve and to selectively fill tanks.

At Mach 3.2, the equilibrium skin temperature on empty portions of the integral tanks will be approximately 500^0 F. Unfortunately, this is near the autogenous ignition temperature of hydrocarbon fuels at

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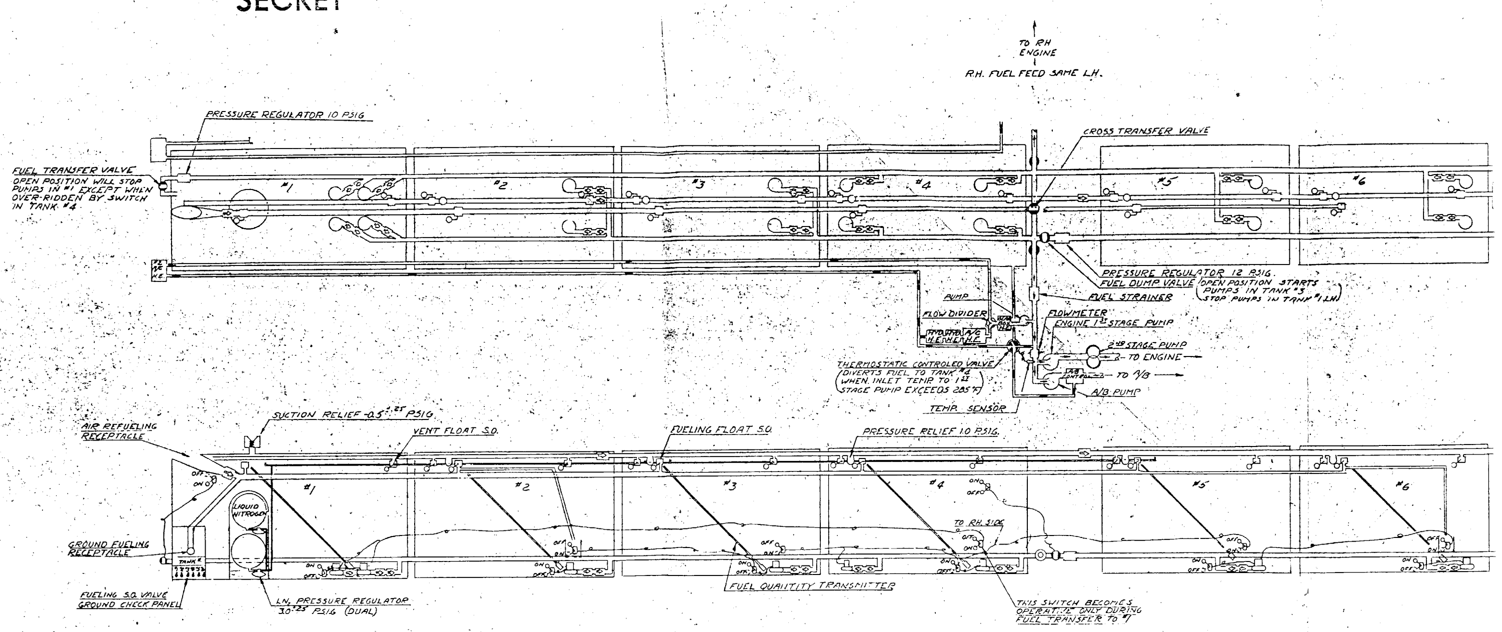

FUEL MANAGEMENT		
TIME	TANKS FEEDING L.H. ENGINE	TANKS FEEDING R.H. ENGINE
T.O.	#1 LH. #2	#1 RH #6
CLIMB	#1 LH. #2	#1 RH #6
6.3 MIN	#2	#6
25.4 "	#3	#6
41.7 "	#3	#5
80.0 "	#4 LH.	#5
138.0 "	#4 L.H.	#4 R.H.

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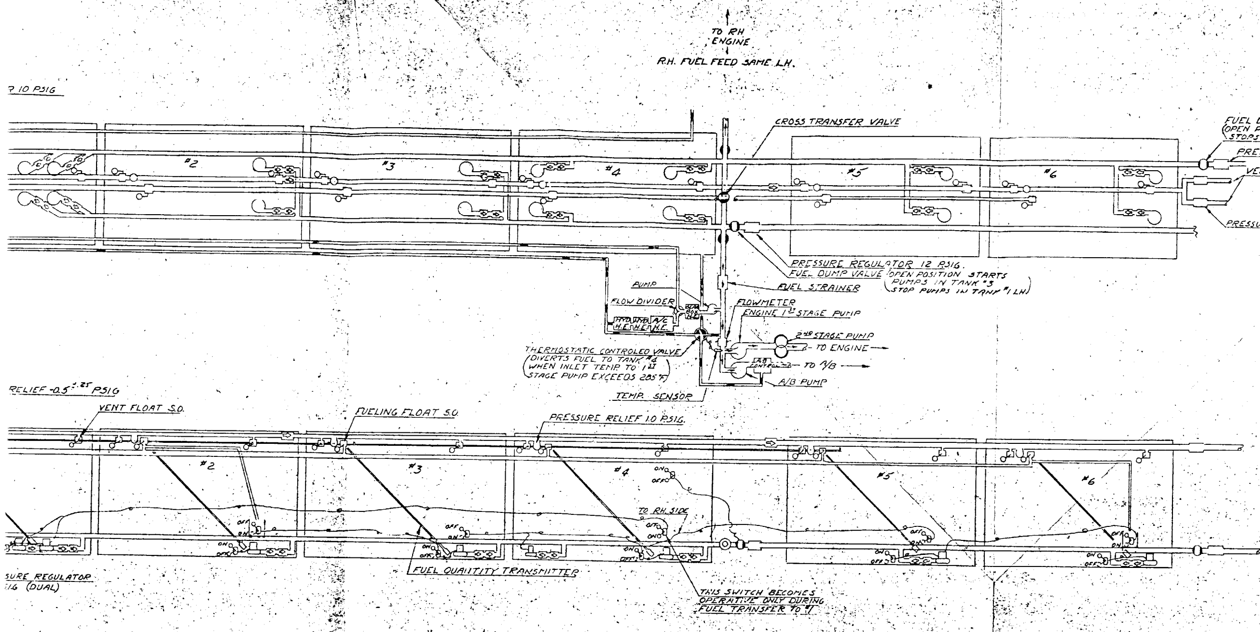
FIG. 4



FUEL MANAGEMENT		
TIME	TANKS FEEDING L.H. ENGINE	TANKS FEEDING R.H. ENGINE
T.O.	#1 LH. #2	#1 RH #6
CLIMB	#1 L.H. #2	#1 RH #6
6.3 MIN	#2	#6
25.4 "	#3	#6
41.7 "	#3	#5
80.0 "	#4 LH.	#5
138.0 "	#4 L.H.	#4 R.H.

CHANGE G

FUEL SYSTEM DIAGRAM
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AIRPLANE DESCRIPTION (cont.)

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Fuel System (cont.)

one atmosphere. [redacted] that the tanks should be inerted until it can be proven that a hazard does not exist.

The inerting gas is nitrogen, carried in liquid form in two 75-liter Dewars located in the nose wheel well. The Dewars are pressurized by internal electrical heating elements which evaporate liquid and build up gas pressure upon a signal from pressure switches.

The inerting nitrogen is delivered to the tanks as a liquid, in order to reduce the size and weight of the pressure demand regulators and the distribution tubes, since the mass flow can be as high as 30 pounds per minute.

The pressure demand regulators are set at 3 PSIG, to insure that the fuel will always be pressurized at least 1 PSI above its boiling point for the worst possible condition.

The tank venting system has been conservatively designed, so that no excessive tank pressure can exist by any malfunctioning fuel system components. Vent float valves are located in both ends of

AIRPLANE DESCRIPTION (cont.)

Fuel System (cont.)

each tank. The forward valve has a pressure relief valve set to crack at 1 PSI above tank pressure.

Pressure is maintained in the tanks by dual pressure relief valves, which are attached to the aft end of the vent line in the fuselage tail cone. These relief valves are set at 4 PSIG or 1 PSI above the pressurizing demand valves.

A suction relief valve on the front of the vent line located in the nose wheel well is set to open at 1 PSI below ambient. This protects the fuselage from damage if the nitrogen supply should be depleted and the airplane were to make a rapid descent.

The quantity of nitrogen aboard is displayed in the cockpit. If a malfunction depletes the supply, the pilot can make a slow descent and allow the structure to cool down, thus eliminating the chance of auto-ignition of the fuel air mixture.

A Minneapolis-Honeywell capacitance fuel quantity system is used to indicate to the pilot the pounds of fuel in each tank, as well as the total fuel aboard. This is displayed in the cockpit by a single indicator. By turning a selector switch, he can gage individual tanks or total.

AIRPLANE DESCRIPTION (cont.)

Fuel System (cont.)

Fuel is delivered to the engines by two or more booster pumps located in each tank, which are plumbed to trunk lines running the entire length of the six tanks. The engine feed lines tap off of the trunk line in the area of the main wheel well. The fuel passes through a strainer and a mass flowmeter before entering the engine pumps.

A cross feed line connects the two trunk lines, so that either engine can be fed from any tank by opening the cross transfer valve. This valve is normally closed.

The airplane center of gravity is controlled by using fuel from the various tanks in the proper sequence. Fuel is used first from the front tanks, to drive the C.G. aft to 28% M.A.C., to minimize trim drag at supersonic speeds. Subsequent fuel usage holds the C.G. at approximately 28% until the descent. Fuel may then be transferred to the empty front tank to improve airplane stability for subsonic flight.

The fuel management is automatic. High and low level float switches turn pumps on and off in a predetermined sequence. The pilot can override the automatic system for any unusual condition which may occur.

AIRPLANE DESCRIPTION (cont.)

Fuel System (cont.)

A dump system is provided which will allow the pilot to dump fuel at the rate of 200,000 pounds per hour. The dump system shuts itself off when the last tank is down to 4,000 pounds.

Approximately 220 pounds of fuel are diverted from the engine feed lines and run through heat exchangers to be used as a heat sink for cooling the cockpits and various systems. This fuel is finally returned to the feed line and burned immediately in the engine.

AIRPLANE DESCRIPTION (cont.)

Air Conditioning and Pressurization

Engine bleed air, extracted from the compressor sections of both engines and then refrigerated, provides both cooling and pressurization for the cockpits and equipment bay. Some limited cooling is also provided by this air in the unpressurized air conditioning compartment and nose wheel well, through which it passes before discharging overboard.

The refrigeration system, shown schematically in Figure 5, features two completely separate systems for dual safety against cockpit overheat conditions. The cockpits are normally furnished with air from the left-hand engine's system, and the right-hand engine system supplies the equipment bay. An "emergency crossover" provision allows the cockpits to take over the output of the entire right-hand system, which normally supplies the equipment bay alone.

Primary cooling of the hot air is accomplished by utilizing both ram air and fuel as heat sinks. The final cooling stage employs a fuel intercooled air-cycle refrigeration machine in the common "bootstrap" arrangement, wherein a transformation from heat energy to mechanical energy serves as the ultimate heat sink. No water boilers are employed in either system, as there is sufficient heat

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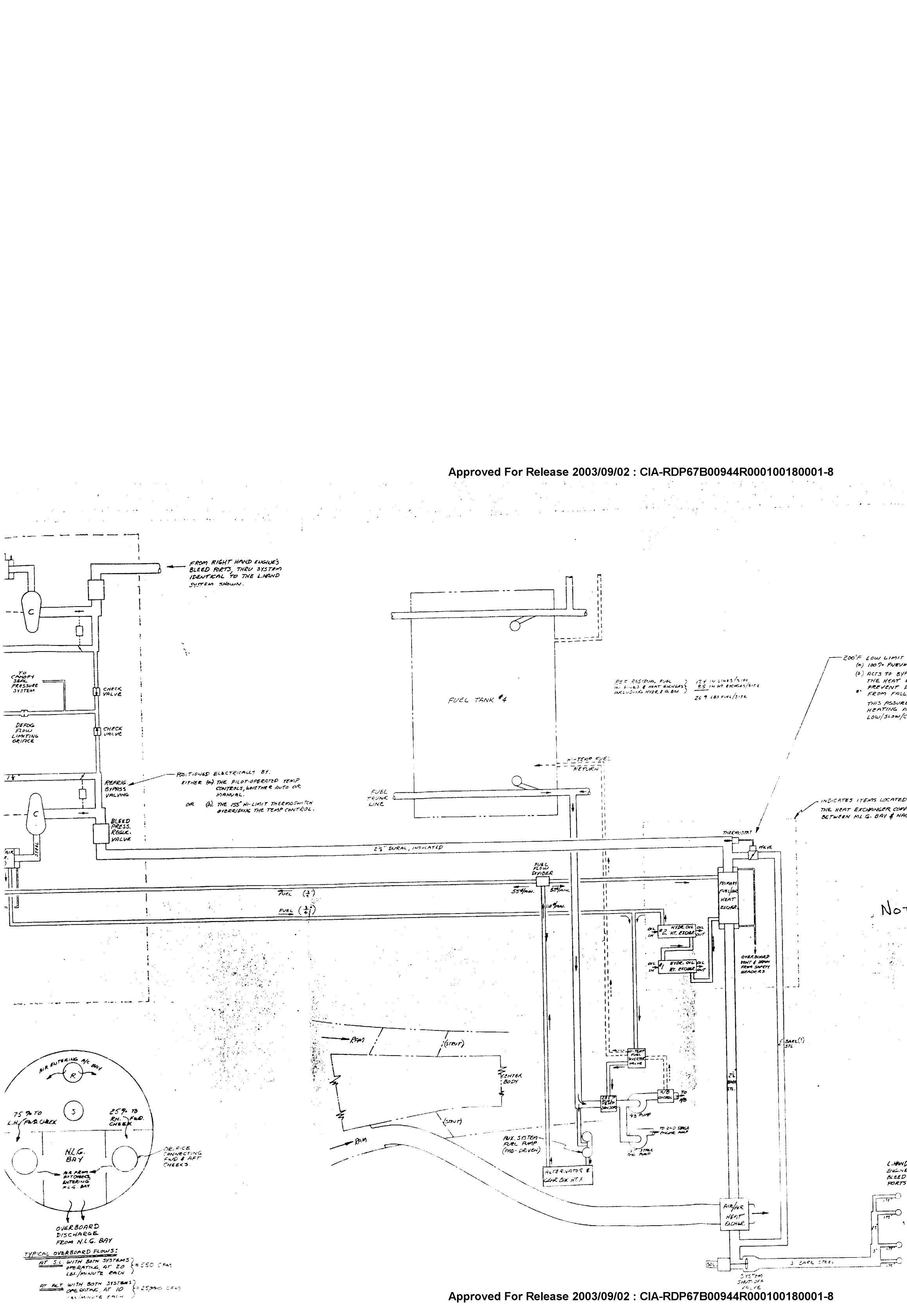
FIG. 5



NOTE:- THIS SCHEMATIC TAKEN FROM A-12 INFORMATION (SINGLE PLACE)

THE TWO-PLACE CONFIGURATION SHALL HAVE A SIMILAR SYSTEM.

SCHEMATIC - AIR CONDITIONING AND PRESSURIZATION SYSTEM

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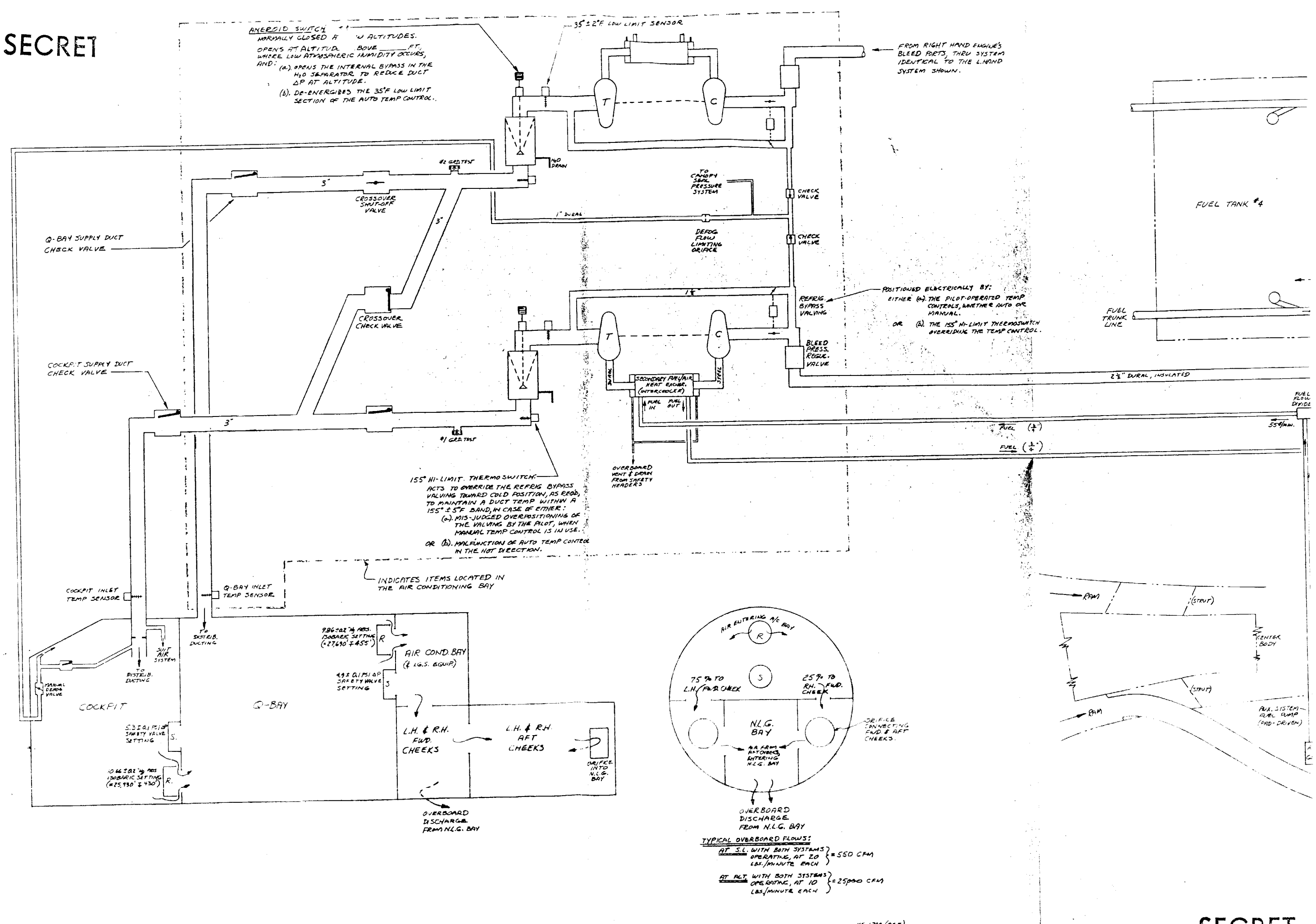

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AIRPLANE DESCRIPTION

Air Conditioning and Pressurization (cont.)

sink available in the fuel for all normal conditions. A condition does exist during low power descent when the present system may not be capable of dissipating the full heat output of the radar system. Further study will be required to determine if this is a realistic condition and, if so, whether a modification of the present system is required.

AIRPLANE DESCRIPTION (cont.)

Oxygen System

Each crew member is supplied with a completely independent dual oxygen system, including a dual emergency system, as shown in Figure 6.

Each oxygen system is of the gaseous type, originating in two 875 cubic inch supply cylinders mounted in the airplane and rechargeable from the outside to a pressure of 1800 psi. The high pressure lines lead to console-mounted, manually operated shutoff and reducer valves, where the oxygen pressure is reduced to 70 psi. Each pair of high pressure lines leads to dual high pressure gages mounted on the left side of the instrument panels.

A low pressure sensor switch in each high pressure line senses the oxygen cylinder pressure. Warning lights on the instrument panel indicate a low pressure condition when the oxygen pressure drops to 500 - 550 psi.

Two 70 psi lines, one from each system, lead from the console valves to a disconnect fitting on the ejection seat. From this breakaway fitting, the 70 psi lines lead to the suit controller which regulates suit pressure and to the inhalation valves in the crew helmet.

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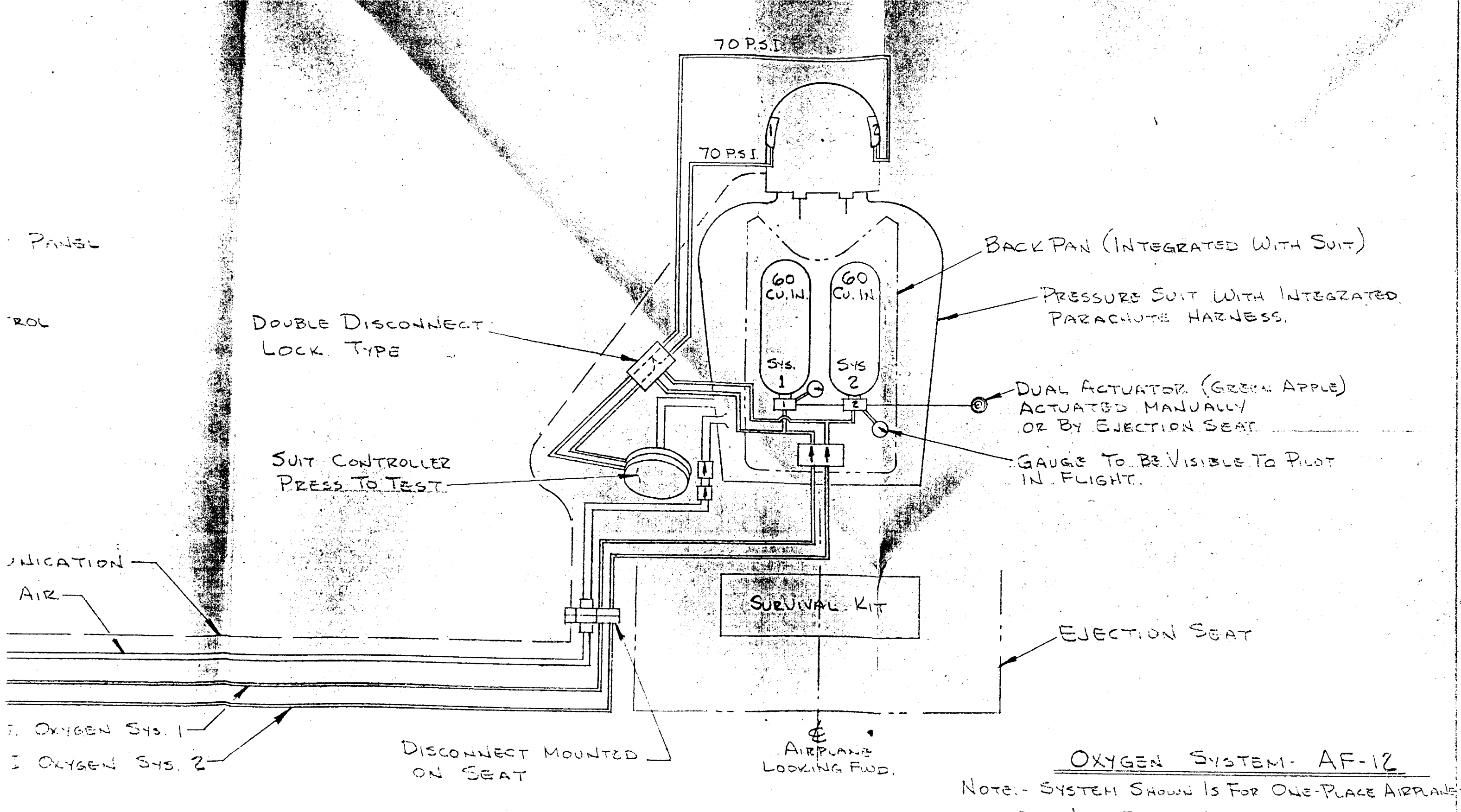
FIG. 6



OXYGEN SYSTEM - AF-12

NOTE. - SYSTEM SHOWN IS FOR ONE-PLACE AIRPLANE - DUPLICATE ENTIRE SYSTEM FOR TWO-PLACE.

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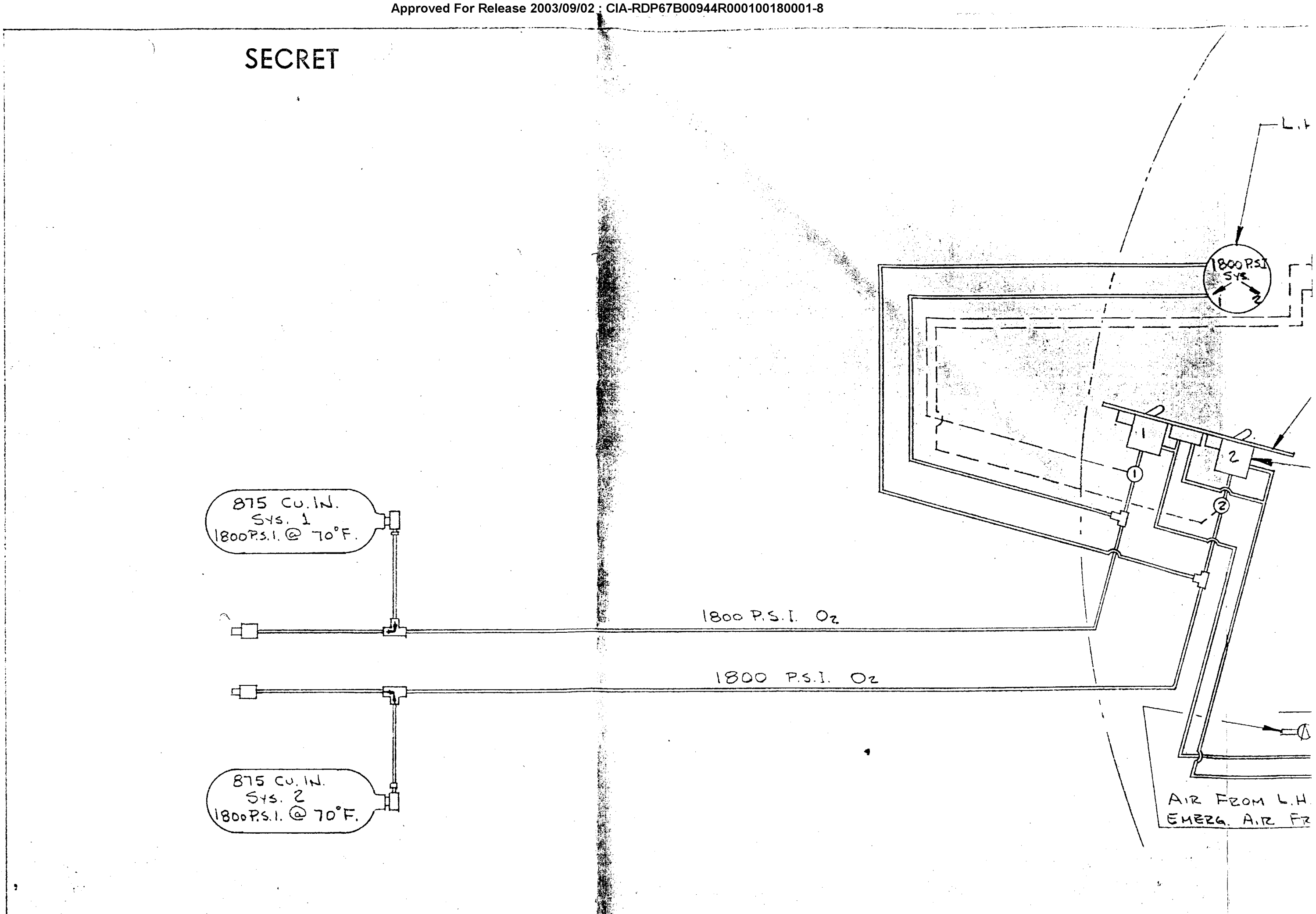

875 CU.IN.
SYS. 1
1800 P.S.I. @ 70°F.
875 CU.IN.
SYS. 2
1800 P.S.I. @ 70°F.
1800 P.S.I. O2
1800 P.S.I. O2
1800 P.S.I.
SYS.
AIR FROM L.H.
EMERG. AIR FR

AIRPLANE DESCRIPTION

Oxygen System (cont.)

Check valves in each line, downstream from the seat disconnect, close upon actuation of the seat disconnect.

A dual emergency oxygen supply is contained in the back pan of the pressure suit and consists of two 60 cubic inch oxygen cylinders. This emergency system can be actuated manually or automatically during seat ejection. Upon closure of the check valves, the emergency system replaces the normal ship's system in the functions of providing suit pressurization and inhalation supply.

The breathing oxygen entering the helmet inflates the visor seal to pressurize the helmet. The oxygen pressure in the visor seal is "locked in" above 15,000 feet and is automatically released by aneroid control below 15,000 feet when the oxygen supply is exhausted, to avoid suffocation of the crewman. The oxygen flow within the breathing cavity provides defogging action for the helmet visor.

A face seal, adjustable by the crewman from the outside of the helmet, seals off the breathing cavity in the front of the helmet from the ventilation air at the back of the head and in the suit. The breathing oxygen pressure is slightly higher than the suit ventilation

AIRPLANE DESCRIPTION

Oxygen System (cont.)

pressure to prevent leakage of ventilation air into the breathing cavity.

A vent line from the ship's air conditioning system leads to each pressure suit through a disconnect fitting on the ejection seat. The vent line flow is manually controlled by each crewman by use of a valve on the left-hand console. A check valve automatically prevents reverse flow and permits suit pressurization when there is no ventilation air flow.

AIRPLANE DESCRIPTION (cont.)

Single-Place Version

The analysis of the interception and fire control functions presented in the fire control section of this report indicate that a single-place interceptor may be feasible. In presenting a single-place arrangement for comparison, it was decided to retain the same basic airframe as the two-place AF-12, in order to retain the capability of building either version with only moderate internal changes. The single-place interceptor is, therefore, externally identical to the two-place airplane shown in Figure 3, except for deletion of the rear canopy and windows.

The pilot's controls and displays are revised to include the essential functions otherwise given to the Fire Control Officer. These changes are described in the fire control section of this report and are reflected in the arrangement shown in the inboard profile drawing for the single-place AF-12, Figure 7. This drawing shows the electronics and computer equipment moved forward into the bay formerly occupied by the Fire Control Officer, and the air conditioning equipment moved out of its normal location above the nose wheel well into the lower half of the former electronics bay. This makes the upper half of the fuselage available for fuel tankage as far forward as the pressure bulkhead. This tank has a capacity of 560 gallons (3,700 pounds), but

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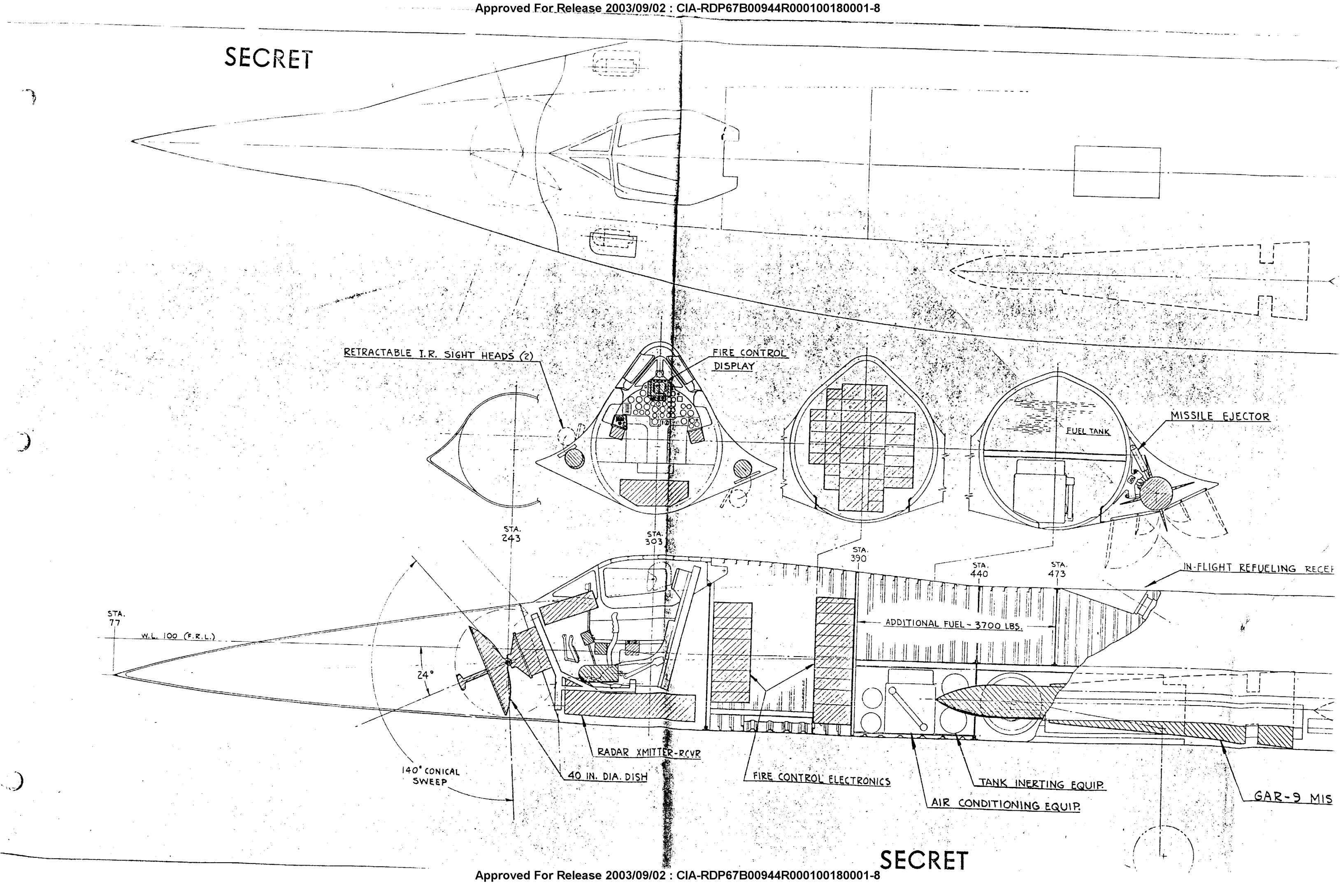

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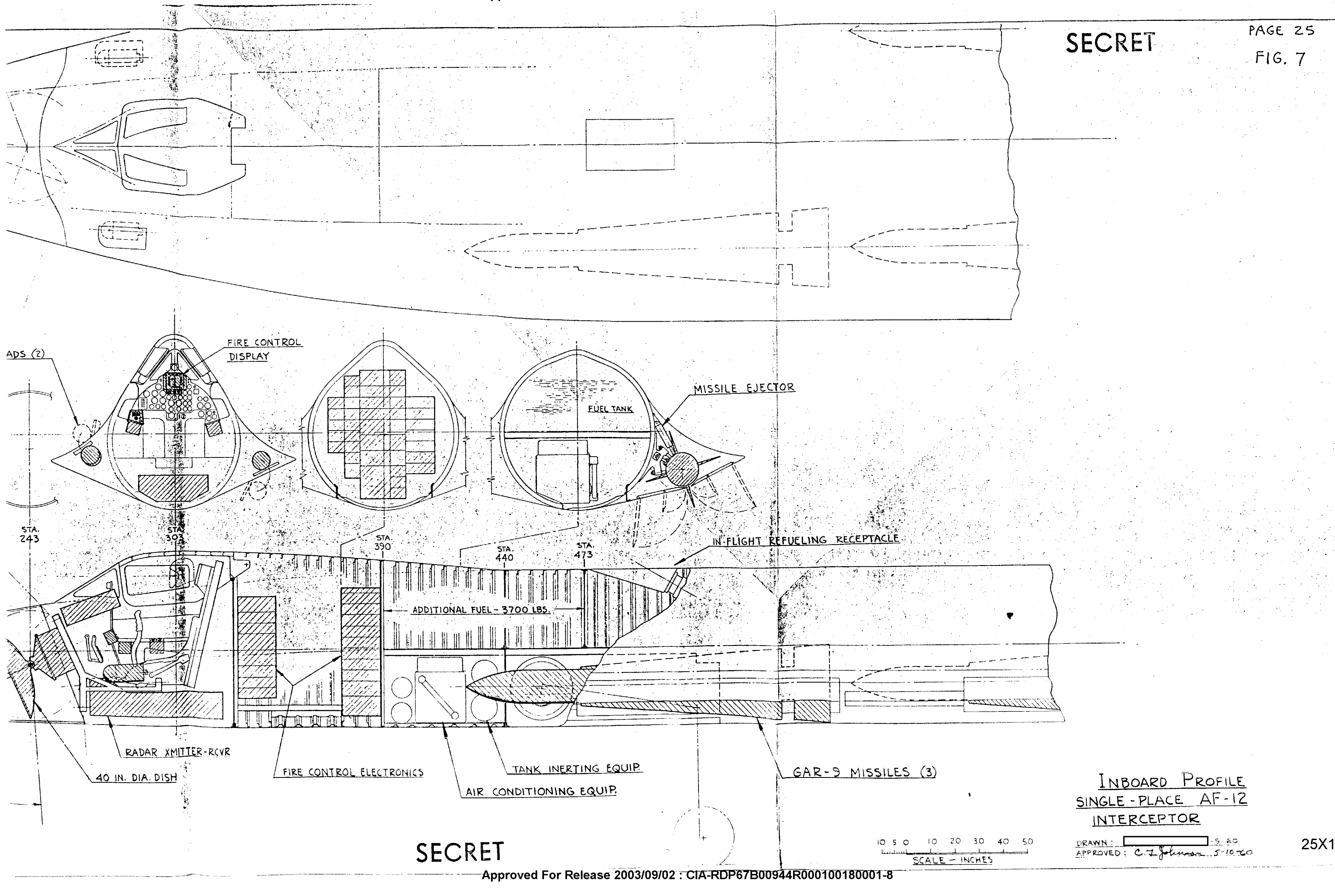
FIG. 7



INBOARD PROFILE
SINGLE-PLACE AF-12
INTERCEPTOR

DRAWN: [redacted] 5-60
APPROVED: C. L. Johnson 5-10-60

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AIRPLANE DESCRIPTION

Single-Place Version (cont.)

its actual usage will depend on weight and balance considerations. The rest of the interior arrangement is the same as for the two-place version, as can be seen by comparison with Figure 3.

This single-place arrangement has considerably more equipment space margin than the two-place version, and it would be quite feasible to shorten the airplane approximately 30 inches by foregoing the capability of ready conversion from one- to two-man operation.

25X1D

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STRUCTURE AND WEIGHT

The structure of the airplane is the result of a three year development program of the materials available to operate in the temperature environment of the A-12. Particular attention was given to the ability of the materials to retain acceptable structural properties after long periods at temperature, and to the fabrication problems and the weight efficiency of the resulting structures. The entire program was directed toward obtaining the lightest and most efficient structural material for the load levels existing in this particular airplane. As a result of this study, it was decided to use titanium alloy [redacted] material for the major portions of 25X1D
the structure utilizing conventional fabrication techniques. In areas where the temperatures are outside the range of this material, [redacted] titanium 25X1D
alloy is used. A structure of comparable weight could be obtained with steel honeycomb panels and extremely intricate internal structure; however, the tooling costs and fabrication problems associated with this method of construction were considered prohibitive.

Design and construction of the A-12 is proceeding using these titanium alloys. Inspection techniques have been established that are more comprehensive than those which any other new material has been subjected to, in order to ensure that all material used in the airplane meets specification in all respects. As would be expected, introducing a new material

STRUCTURE AND WEIGHT (cont.)

with the additional high temperature operational requirement has produced some problem areas. These have been of a minor nature, and we are confident that [redacted] can be assimilated with no more and perhaps fewer teething troubles than were experienced in the introduction of the 75S aluminum alloy.

25X1D

LOAD CRITERIA

The loads are derived from conditions which, in general, meet the intent of the structural criteria of the MIL-A08860 (ASG) series of USAF and BuAer specifications. Conditions which are considered impractical, or which do not fit the intended use of the airplane, are modified or eliminated. Specifically, these items are:

1. Landing Weight - Specification requires that the airplane be designed to land with 40% of fuel aboard (24,240 pounds), at a sinking speed of 10 feet per second. The AF-12 is fitted with a fuel dump system with a maximum fuel dump rate of 3,400 pounds per minute. In view of this fuel dump capability, the AF-12 is designed for a landing weight of 65,000 pounds (10,000 pounds of fuel aboard) at a sinking speed of 10 feet per second.

2. Level Flight Speed V_H - Specification requires maximum speed in level flight using military power. This is an impractical

STRUCTURE AND WEIGHT (cont.)

LOAD CRITERIA (cont.)

requirement for this airplane, with its high thrust-to-weight ratio at low altitude. The AF-12 design speeds are: 25X1D

4. Spins - The airplane is not designed to spin.

The load criteria defined above allow the basic wing, fuselage, nacelle and empennage structures of the A-12 to be retained. The strength of the landing gear and its support structure is increased to meet the higher requirements of the AF-12.

The maneuver load factor capability of the A-12 structure is incorporated in the AF-12. The degradation of performance and increased cost in providing higher load factors was considered inadvisable, since all the foreseeable missions of the airplane can

STRUCTURE AND WEIGHT (cont.)

LOAD CRITERIA (cont.)

be performed with the present maneuver load factor envelope. Figure 18 shows the maneuver load factor capability of the airplane plotted against weight. It can be seen that at the 77,000 pound combat weight for the 1,000 N.M. area intercept mission, a maneuver load

25X1D [redacted] is permissible. This factor allows ample capability for an escape maneuver to avoid blast effects. Figure 18 shows, for information only, the increase in load factor capability possible by 360 pounds of beef-up in the nacelle and outer wing.

WEIGHT AND BALANCE

The weight estimate for the two-place airplane is given on pages 46 to 48. These weights reflect all the changes made to the A-12 airplane to provide the interceptor capability. For the single-place airplane, the Zero Fuel Weight is reduced by 1,185 pounds and the fuel capacity increased by 560 gallons or 3,700 pounds at 6.6 lb/gal.

The airplane balance envelope for the 1,000 N.M. area intercept mission is shown in Figure 19. The aft center of gravity shown for the cruise portion of the mission gives low trim drag, and is obtained by a selective use of fuel. The airplane balance in flight can be controlled by transferring fuel into the extreme aft or

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STRUCTURE AND WEIGHT (cont.)

WEIGHT AND BALANCE (cont.)

extreme forward tanks. For the mission shown, fuel is transferred into the aft tank during the outward leg. For the combat and cruise home portions of the mission, the system operates automatically.

Next 3 Page(s) In Document Exempt

AN/ASG-18 - GAR-9

INTERCEPTOR FIRE CONTROL/MISSILE SYSTEM

The basic proposal of the AF-12 interceptor is a two-place version utilizing the basic AN/ASG-18 - GAR-9 fire control and missile system as developed for the F-108. However, since an analysis of the ASG-18 suggests that its various controls and displays may be sufficiently simplified so the pilot might operate it, a single-place version of the AN/ASG-18 has also been described.

TWO-PLACE VERSION

A diagram of the two-place version of the AN/ASG-18 GAR-9 fire control system, as it was planned for the F-108, is shown in Figure 20. It is operated by a Fire Control Officer (FCO), who filters and interprets obtained information, and channels the resulting steering signals over to the pilot's display. The following system description indudes performance, functions of controls and displays, and environments.

Radar Detection Range

Radar detection range with a 40-inch dish is equivalent to the F-108, i.e., well above the required 100 N. Mi. The use of a 36-inch dish will cause a reduction of about 10 per cent. Under favorable conditions, the I.R. range is comparable to, and may exceed, that of radar.

Navigation Accuracy

25X1D

25X1D

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